University of Missouri

Undergraduate Research & Creative Achievements Forum

2020 Summer

July 30- Aug. 5, 2020

Exhibited online thru a collaboration of the
University of Missouri Libraries
and the
Office of Undergraduate Research

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https://tinyurl.com/2020SummerForum

With 50 students presenting scholarship on a
variety of disciplines from across the Mizzou campus.

We would like to thank all of the students, mentors, faculty, and administrators
for their time and effort in making this digital exhibition of scholarly works possible.

It is our hope, that all involved will find this to be an
engaging educational experience.

~ Office of Undergraduate Research

Office of Undergraduate Research

Vision

Mizzou strives to advance a culture where all interested undergraduates engage in a quality research or creative scholarship experience.

Mission

The Mission of the Office of Undergraduate Research is to foster and support mentored undergraduate research, scholarship and creative activity in a premiere research environment.

Goals

Fostering growth of the practice of undergraduate research and creative scholarship

Maximizing the student experience and enhancing quality of the experience

Increasing visibility of the opportunities and outcomes of undergraduate research

Serving as a central resource for MU students, mentors, programs, and departments

150A Bond Life Sciences Center
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2019-2020 Undergraduate Research Advisory Committee

We would like to thank our Advisory Committee for their insight, support and continued engagement with Undergraduate Research and our office.

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Chair, Psychological Sciences

Elizabeth Chang
Associate Professor, English

Roger Fales
Director of Student Success and Mentoring, College of Engineering

Jerritt Frank
Associate Professor, History

Sharyn Freyermuth
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Director of School of Visual Studies

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Associate Dean, College of Human Environmental Sciences

2020 Summer Undergraduate Research & Creative Achievements Forum

2019-2020 Undergraduate Research Advisory Committee

continued...

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Lisa Scheese
TRiO Student Services Coordinator

David Schulz
Honors Director, Biological Sciences

Undergraduate Research
University of Missouri

2020 Undergraduate Research & Creative Achievements Forum

Due to the COVID-19 pandemic, more than ten formal summer undergraduate research programs for visiting students were cancelled. One program, NSF REU in Consumer Networking Technologies, was able to continue with all students conducting research remotely. On-campus research for MU students was severely curtailed, with all students at the beginning of the summer. By mid-July, some MU students were able to return to their laboratories; however, the majority of the research presented in the Summer Forum was conducted off-campus, with social distancing protocols in place and mentoring conducted through email, phone calls, and video conferencing. We thank the students, mentors, and research teams mates for their flexibility this summer.

The Summer 2020 Undergraduate Research & Creative Achievements Forum represents the 31st year of research intern presentations at the University of Missouri. Almost 50 students presenting their projects at the Forum come from four formal programs and individual faculty research funding. Faculty mentors represent 20 departments in seven colleges and schools at the University of Missouri.

Participating MU Departments & Divisions

Cherng Summer Scholars Program- Honors College

The Cherng Summer Scholars program, funded by Peggy and Andrew Cherng and the Panda Charitable Foundation, supports students who have achieved scholarly success in their academic discipline and demonstrated leadership across campus. Cherng Summer Scholars participate in individually designed theoretical research, applied research, or artistry projects, under the mentorship of an MU faculty member. In its fourth summer this year, the Cherng Summer Scholars program has been recognized as one of the top summer research placements at MU. Participating students are exposed to high-impact experiences and unique opportunities that transcend the traditional classroom. This program combines the University's position as a leading research institution with the talent of these already accomplished undergraduate scholars.

Honors College Director	Dr. J.D. Bowers
Seminar Director	Dr. Susan Lever
Program Coordinator	Ava Drayton

MARC/IMSD Program
NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

The MARC (Maximizing Access to Research Careers)/IMSD (Initiative for Maximizing Student Diversity) program is designed to enhance the experience of a diverse group of students at MU through research opportunities, workshops, and mentoring. This mission of this program is to encourage underrepresented minority students to earn a doctoral degree and pursue a research career in a field related to biomedical research. MARC/IMSD Fellows complete an independent research project.

Principal Investigator	Dr. Mark Hannink, Biochemistry
Co-Principal Investigator	Dr. Linda Blockus, Undergraduate Research
Undergraduate Director	Brian Booton, Undergraduate Research
Administrative Assistant	Kristi Head, Undergraduate Research

National Science Foundation - Research Experience for Undergraduates
(Consumer Networking Technologies)

The REU projects will investigate important issues related to software-defined networking, visual computing at the network edge, social health networking for eldercare, body-area sensing and emotion recognition. As broadband services and mobile devices proliferate, consumers are migrating towards advanced social, information-intensive, and personalized services. The fast pace of growth, improvement to quality of life, and significant economic contribution of networked consumer systems have been receiving increasing attention. Technical challenges in this field include quality of service, network and device heterogeneity, network performance, mobility, device intelligence, security and privacy, and user experience and knowledge. In this REU Site, students participate and develop new skills in ongoing funded research projects of the faculty mentors by investigating, implementing, and testing viable solutions to technical challenges in consumer networking technologies. This research activity allows the students to obtain a better understanding of the technical issues, performance, and trade-offs in consumer networking. Exposing the students to collaborative research environments, fostering their enthusiasm for science and engineering, and developing skills needed for pursuing advanced degrees in research is a goal of this program

Principal Investigator Dr. Prasad Calyam, Electrical Engineering & Computer Science

Undergraduate Research & Creative Achievements Forum

Student Presenters

Ganasri Aleti

Su20-009

Chesterfield, MO

Sophomore
Psychology; Biological Sciences

Faculty Mentor: Dr. Anand Chandrasekhar, Biological Sciences

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Optimizing the Intermedilysin(ILY)- hCD59 Receptor System of Rapid Cell Ablation in Zebrafish

Ganasri Aleti and Anand Chandrasekhar

Targeted cell ablation is a powerful and important tool for studying cellular processes. Yet current methods are slow, requiring hours to days, making them unsuitable for studying rapid cellular events lasting seconds to minutes. The Chandrasekhar lab is testing a novel rapid cell ablation technology, hCD59-ILY, for feasibility in zebrafish. To do so, the lab generated a transgenic zebrafish line *Tg(zCREST:ZsGreen-P2A-hCD59)* that expresses the human CD59 receptor and zsGreen fluorescent protein in branchiomotor neurons. While preliminary cell culture studies demonstrated that these neurons undergo rapid cell lysis following treatment with ILY protein, the conditions for rapid cell ablation in vivo remain to be optimized. My project will test several combinations of hCD59 receptor and ILY protein concentrations to determine the optimal expression levels for efficient cell ablation in zebrafish embryos.

Tg(zCREST:ZsGreen-P2A-hCD59) zebrafish will be set up for breeding and embryos will be collected for treatment. The mRNA encoding the hCD59 receptor will be injected into the yolk syncytial layer approximately 3 hours post-fertilization then incubated in intermedilysin for 12 hours. The concentrations are as follows: ILY doses will be 4, 20, 40 µg/mL at constant hCD59 mRNA level. Several hCD59 mRNA doses (0.5, 1, and 2 ng mRNA per embryo) will be tested. The ILY-treated embryos will be examined to determine which combination produces the highest percentage of embryos with necrotic region formation. Western Blots will also be performed on select embryos from each treatment to verify the level of hCD59 expression. It is expected that an optimal combination of hCD59 receptor and ILY protein will be found that causes maximal tissue lysis, making such a combination both efficient and effective. These findings can be used for neuroscience and developmental biology research, especially in our own lab.

Brendan Ball

Su20-050

O'Fallon, MO

Junior
Biological Sciences; Psychology

Faculty Mentor: Dr. Habib Zaghouani, Molecular Microbiology and Immunology

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Evaluating Environmental Influence On T-Cell Development In Type One Diabetes

Brendan M Ball, Alexis N Cattin-Roy, Tobechukwu K Ukah, and Habib Zaghouani

T1D, sometimes known as juvenile diabetes, is a chronic autoimmune disease in which the pancreas produces little to no insulin. This happens with the damaging of the beta-cells, insulin-producing cells, in the islets of Langerhans by the immune system. This immune system attack leads to apoptosis of beta cells, thus establishing insulin deficiency and hyperglycemia which can lead to major health concerns such as ketoacidosis (buildup of acids in the bloodstream), kidney failure, heart disease, stroke, and blindness. Type One Diabetes (T1D) currently affects about 1.6 million people in the United States with about 64,000 new cases diagnosed every year. Although the genetic factors of patients play a huge role in their diabetes susceptibility, there are significant environmental implications that play a role in diabetes susceptibility in patients. Factors in the environment, such as parasitic infections, induce chemical mediators called cytokines. IL-4 is a cytokine that is known for having ties to preventing autoimmunity. If we inject IL-4 cytokines to act as an environmental factor in the thymus, then that will alter central tolerance and stop the targeting of beta cells by escaped autoreactive T cells. To test this, we will be using the non-obese diabetic (NOD) strain of mouse, which is a model that is able to develop spontaneous autoimmune diabetes that shares a lot of similarities to T1D in human subjects, such as pancreas-specific autoantibodies, autoreactive CD4+ and CD8+ T cells, and genetic linkage to the disease. We will inject IL-4 into the thymus, as well as saline for our control group, to test if this affects T cell development and to see its effects on diabetes. We will have multiple experimental readouts including sequencing the variable regions of the T cell receptors to look at the T cell repertoire and also check blood sugar as the mice get older. From our research we are expected to be able to alter the T cell repertoire and have one that is consistent with a healthy immune response (No beta-cell autoantigen specific receptors and good diversity). Previous research in our lab has shown that IL-4 aids in the production of thymic cells that preform central tolerance thus tightening T cell selection. This leads to the hypothesis that intra-thymic IL-4 will tighten central tolerance in the NOD and reduce the number of autoreactive cells in turn leading to less disease. If the expected findings are met, they could then be translated into human research to provide therapeutic approaches to preserve central tolerance.

Alexandria Becks

Naperville, IL

Su20-047

Junior
Biological Sciences

Faculty Mentor: Dr. Anand Chandrasekhar, Biological Sciences

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Evaluating Neuronal Migration in Celsr1 and Wnt5a Double Mutants

Alex Becks and Anand Chandrasekhar

Defective neuronal migration during development can contribute to several brain disorders, including epilepsy. The goal is to understand the mechanisms of neuronal migration to help remedy these human brain disorders. Since the migration pathways of the Facial Branchiomotor (FBM) neurons are well-studied and an evolutionarily conserved process, this system will be used as the model to investigate the mechanisms involved. The current model proposes that the function of the chemoattractant Wnt5a is blocked by the membrane receptor Celsr1 to prevent inappropriate rostral migration. Previous studies with *Wnt*-soaked beads showed that excess Wnt5a can induce rostral migration. In addition, *Celsr1* mutants exhibited a rostral migration phenotype, suggestive of a role for Celsr1 in suppressing chemoattractant activity. To further test our model, both the *Celsr1* and *Wnt5a* genes will be knocked out and the migration phenotype will be examined. In order to generate the double knockout phenotype, the double heterozygous *Celsr1*$^{+/KO}$ *Wnt5a*$^{+/KO}$ mouse line must be generated. The lab has crossed *Celsr1*$^{+/KO}$ and *Wnt5a*$^{+/KO}$ single heterozygote mice to generate double heterozygotes. After genotyping to identify the mice, a two-factor cross will be performed to produce embryos that are homozygous mutant for both *Celsr1* and *Wnt5a*. The double mutants will be identified through genotyping performed on embryonic day 12. A corollary experiment will test whether *Celsr1* mutants exhibit enhanced rostral migration when *Wnt5a* is overexpressed.

Identifying the mechanisms involved in neuronal migration helps scientists begin to understand the migration process. Directed cell migration, such as the movement of neurons during development, is essential to ensuring the health of the animal. Thus, the experiments performed in the lab can help us to understand human birth defects like spina bifida, cleft palate, and cardia bifida (all of which are due to the failure of cell types to orient and migrate properly).

Madison Billingsly

Su20-012

Green Ridge, MO

Senior
Biological Sciences

Faculty Mentor: Dr. Mary Beth Miller, Psychiatry

Funding Source: University of Missouri Research Board and the National Institute of Alcohol Abuse and Alcoholism (K23AA026895) to Mary Beth Miller

Discrepancy in Self-Report and Actigraphic Measures of Sleep among Heavy-Drinking Young Adults

Madison R. Billingsley, Nicole A. Hall, and Mary Beth Miller

Objective: Studies have shown a discrepancy between objective and subjective sleep measures in a variety of populations. This study examined the relationship between objective and subjective sleep measures to determine (a) if this discrepancy exists for heavy drinkers with insomnia and (b) if heavier drinking was associated with greater discrepancy.

Method: Sixty heavy drinking participants with insomnia (15% Veteran, 35% male) filled out daily sleep diaries and also wore an actigraphy watch in order to obtain both objective and subjective measures of sleep. Average sleep efficiency (SE), wake-after-sleep-onset (WASO), and sleep onset latency (SOL) were determined for each participant over a 7-day period using both objective and subjective measures.

Results: Paired samples t-tests showed a significant difference between dairy (M=22.40, SD=18.78) and actigraphy (M=47.50, SD=17.44) WASO scores, $t(59)=-7.10$, $p<.001$. A significant difference was also present between diary (M=88.45, SD=6.33) and actigraphy (M=77.44, SD=6.45) SE scores, $t(59)=9.22$, $p<.001$. A non-significant difference was found between diary (M=40.51, SD=25.23) and actigraphy (M=48.14, SD=29.03) SOL scores, $t(59)=-1.627$, $p=.11$. Given the discrepancy between objective and subjective measures of sleep disturbance, linear regression was utilized to determine if level of alcohol consumption was associated with discrepancy in sleep efficiency, controlling for Veteran status and participant sex. The overall regression model was not a significant, $F(3,56)=0.70$, $p=.56$; and alcohol consumption was not a significant predictor within the model, $B=0.10$, $SE=0.92$, $p=.92$.

Conclusion: Heavy-drinking young adults with insomnia tend to underestimate the amount of time that they are awake in the middle of the night and overestimate the efficiency of their sleep. However, these discrepancies are not explained by the amount of alcohol that they consume. Given the restricted range of drinking in this sample, future studies may determine if alcohol use predicts sleep discrepancy in samples that also include non-drinking and lighter-drinking participants.

Maxwell Chappell

St. Louis, MO

Su20-027

Senior
Computer Science
Truman State University

Faculty Mentor: Dr. Marjorie Skubic, Electrical Engineering & Computer Science

Funding Source: NSF REU in Consumer Networking Technologies

Fall Risk Prediction in Older Adults from EHR Nursing Notes

Maxwell Chappell, Sarah Emerson, Anup Mishra, and Marjorie Skubic

Electronic health records (EHR) are complex and contain both structured (e.g. physiological measures) and unstructured (e.g. nursing notes) health data. Studies show that EHR nursing notes contain critical health information, including fall risk factors in older adults. Older adults age 65 and above are at higher risk of fall. Predicting fall risk early could provide caregivers enough time to provide interventions. Several fall risk prediction models have been proposed in the literature; however, an exploration of fall risk prediction using nursing notes is missing. In this study, we explore deep learning architectures to predict fall risk in older adults using nursing notes in the EHR. In this IRB-approved study, we used EHR data obtained from 162 older adults at TigerPlace, a senior living facility located in Columbia, Missouri. The data included de-identified free-text nursing notes and medications. We pre-processed the data by keeping clinically relevant words. We used pre-trained word embedding models, specifically BioWordVec, and GloVe to train the models. We explored several deep neural architectures and evaluated them to test the effectiveness of each model in predicting future falls. Preliminary experiments show that the LSTM-based deep neural models were most effective in predicting future falls with a sensitivity of 0.72, specificity of 0.67, and a prediction accuracy of 0.75. The model used six months of nursing note data to predict future falls in the next two months. We observed that deep learning models performed better in predicting future falls in a shorter time range as compared to falls in distant future. In addition, the BioWordVec word embedding model was able to capture 17% more clinically relevant words in the text data when compared to GloVe. This exploratory analysis provides groundwork on the use of word embeddings in predicting fall risk from nursing notes.

Helen Chen

Newton, MA

Su20-021

Junior
Computer Science
University of Maryland, College Park

Faculty Mentors: Dr. Prasad Calyam, Electrical Engineering & Computer Science; Dr. Kannappan Palaniappann, Electrical Engineering & Computer Science

Funding Source: NSF REU in Consumer Networking Technologies

Truth, Trust, and Transparency in Synthetic Media

Helen Chen, John Jack Lewis, Imad Eddine Toubal, Vishal Sandesera, Michael Lomnitz, Zigfried Hampel-Arias, Kannappan Palaniappan, and Prasad Calyam

Authenticity of digital media has become an everpressing necessity for modern society. Since the introduction of Generative Adversarial Networks (GANs), synthetic media has become increasingly difficult to identify. Synthetic videos that contain altered faces and/or voices of a person are known as deepfakes and threaten trust and privacy in digital media. Deepfakes can be weaponized for political advantage, slander, and to undermine the reputation of public figures. Despite imperfections of deepfakes, people struggle to distinguish between authentic and manipulated images and videos. Consequently, it is important to have automated systems that accurately and efficiently classify the validity of digital content. Many recent deepfake detection methods use single frames of video and focus on the spatial information in the image to infer the authenticity of the video. Some promising approaches exploit the temporal inconsistencies of manipulated videos; however, research primarily focuses on spatial features. We propose a hybrid deep learning approach that uses spatial, spectral, and temporal content that is naturally coupled in a consistent way to differentiate real and fake videos. In this work, we build a computationally efficient cloud-ready multimodal system to detect deepfake videos. We evaluate the performance of our proposed system compared to recent approaches, in terms of accuracy and speed, on the Facebook Deepfake Detection Challenge and FaceForensics++ video datasets.

Bana Daghlas

Columbia, MO

Su20-040

Senior
Biochemistry

Faculty Mentor: Dr. Lesa Beamer, Biochemistry

Funding Source: LIfe Science Undergraduate Research Opportunity Program (LS UROP)

Characterizing variants of Serine Hydroxymethyltransferase (SHMT) to further elucidate mechanism of resistance against soybean cyst nematode (SCN) infection

Bana Daghlas and Lesa Beamer

Soybean cyst nematode (SCN) infection is a billion dollar problem annually in United States agriculture. Soybean cyst nematode is a parasitic roundworm which infects soybean plants by targeting roots and establishing permanent feeding sites. Infection can lead to stunted growth, yellowing, and general decrease in crop yields. Currently, resistant cultivars are used to combat SCN infection. However, nematodes are becoming increasingly resilient against these cultivars, and the exploration of a novel path to combating SCN infection is crucial. Pioneering research from the lab of Dr. Melissa Mitchum uncovered that a variant of the enzyme Serinehydroxymethyltransferase (SHMT), found in the soybean genotype Peking, is resistant to SCN infection due to two point mutations. Soybeans contain 18 different SHMT genes, with SHMT8 being the only family member associated with SCN resistance. The SCN susceptible cultivar of SHMT8, called Essex, varies from the SCN resistant cultivar, called Forrest, by just two point mutations. In order to explain the mechanism of resistance found in SHMT8, sequences from the SHMT family were studied to identify similarities and differences. I have identified 12 SHMT sequences from the UniProtKB database and conducted a multiple sequence alignment to examine relationships. Pairwise differences were calculated to quantitate amino acid similarity and a homology tree was constructed to visualize sequence relationships. Additionally, structural models have been created using Swiss-Model to simulate how amino acid differences may affect the structure of the protein. In the next phase of the study, further analysis of the structures and sequences of the SHMT family will be done to elucidate how secondary structure differs and which key catalytic residues are affected. These observations will provide further insight into the mechanism of resistance of SHMT8 Forrest against SCN infection and perhaps contribute to the solution to SCN infection.

Thomas DeLong

Kansas City, MO

Su20-046

Senior
Biological Sciences; History

Faculty Mentors: Dr. Bing Zhang, Biological Sciences

Funding Source: Cherng Summer Scholars-Honors College, funded by Peggy and Andrew Cherng and the Panda Charitable Foundation

Eaat1 and Sleep in the Fruit Fly Drosophila melanogaster

Thomas DeLong, Paul Shaw, and Bing Zhang

The biological mechanisms of sleep are poorly understood. Recent research has suggested that glial cells, the non-neuronal cells of the brain, play a role in regulating sleep behavior. My research is focused on the glial protein Eaat1, which seems to affect sleep by regulating glutamate signaling between neurons. To examine this relationship, I measured the sleep patterns in flies in which the expression of Eaat1 was altered. This was one using our video based system DART and the infrared beam DAM system at Paul Shaw's lab at Washington University. Currently, we have measured the sleep of over three hundred flies using these systems. Preliminary analysis has confirmed that Eaat1 is associated with irregularities in sleep. I am working on setting up programs that will analyze the data in a more sophisticated way and allow us to describe the changes in sleep behavior more precisely. I am also creating genetic crosses to decrease Eaat1 expression in more specific groups of cells. After that, the next steps will include analysis of Eaat1 mutants, imaging of Eaat1 at synapses, and targeted reduction of glutamate release in neurons associate with sleep.

De'anne Donnell

Kansas City, KS

Su20-034

Junior
Nutrition and Exercise Physiology
(Physical Activity, Nutrition and Human Performance)

Faculty Mentor: Dr. Elizabeth King, Biological Sciences

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

The influence of environmental conditions on lifespan and alcohol intake in Drosophila melanogaster

De'anne Donnell, Enoch Ng'oma, and Elizabeth King

The environment that one experiences is often a major determinant of many health-related phenotypes, however, we do not fully understand these effects and how they differ depending on the genotype of an individual. In order to explore these effects, two experiments were designed to better understand how the environment influences key health-related phenotypes, both using the model system *Drosophila melanogaster*. First, we will test how different diet environments affect the lifespan of *D. melanogaster*. Previous studies have shown that diets of high sugar cause a reduction in life span in flies, and a dietary restriction diet causes a longer lifespan in flies. We show that the flies on the high sugar treatment had a shorter lifespan than the control and dietary restriction groups. Second, we plan to test the relationship between social isolation and alcohol intake in *D. melanogaster*. Research has shown that using perceived social isolation can decrease lifespan in fruit flies, increase obesity in rats, and cause humans to have a faster cognitive decline (Hawkley & Cacioppo, 2009). We expect social isolation will cause flies to consume more alcohol-containing food than fruit flies that are not isolated. The purpose of these experiments is to increase our understanding of how environmental conditions influence behaviors and life history traits, with the broader goal of connecting this model to human health.

Esirioghene Emeje

St. Louis, MO

Su20-039

Senior
Psychology

Faculty Mentor: Dr. Bradley Ferguson, Health Psychology

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Effects of the beta-adrenergic antagonist propranolol on adaptive and problem behavior and relationship with heart rate variability in patients with autism spectrum disorder

Esirioghene Emeje, Kathy Hirst, Julie Muckerman, Katie Bellesheim, Nicole Takahashi, David Beversdorf, and Bradley Ferguson

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that affects many individuals in the United States. According to the CDC, its prevalence is on a continual rise with a 15 percent increase nationally affecting 1 in 68 children in the United States. Rates of ASD are more prevalent in young adolescent boys then compared to girls. One of the main issues that affects children with ASD is their ability to communicate and their behavior. People, who suffer from ASD, have difficulty with social communication and social interaction, causing them to behave in socially unacceptable ways at times. As such, it is important to find ways to help increase socially-appropriate behavior in ASD and maximize their social communication and interaction. Multiple studies indicate that ASD may be characterized by hyper-restrictive associative networks, which may be related to increase noradrenergic signaling in the brain. These findings suggest the potential benefit of a pharmacological agent aimed at the noradrenergic system for this population. Research indicates that propranolol, a pharmaceutical drug that blocks the brain and body's use of norepinephrine both centrally and peripherally, reduces noradrenergic system activity. As a result, propranolol also decreases blood pressure and reduces anxiety. A previous study in our lab examined the effects of serial doses of propranolol, on social interactions and secondarily on language tasks, anxiety and adaptive behavior in high functioning adults and adolescents with ASD. We found that when taking the serial doses of propranolol for 15 weeks, it helps benefit people with autism in the realm of social interaction and anxiety.

Sarah Emerson

Columbia, MO

Su20-026

Junior
Computer Science; International Studies
Samford University

Faculty Mentor: Dr. Marjorie Skubic, Electrical Engineering & Computer Science

Funding Source: NSF REU in Consumer Networking Technologies

Fall Risk Prediction in Older Adults from EHR Nursing Notes

Sarah Emerson, Maxwell Chappell, Anup Mishra, and Marjorie Skubic

Electronic health records (EHR) are complex and contain both structured (e.g. physiological measures) and unstructured (e.g. nursing notes) health data. Studies show that EHR nursing notes contain critical health information, including fall risk factors in older adults. Older adults age 65 and above are at higher risk of fall. Predicting fall risk early could provide caregivers enough time to provide interventions. Several fall risk prediction models have been proposed in the literature; however, an exploration of fall risk prediction using nursing notes is missing. In this study, we explore deep learning architectures to predict fall risk in older adults using nursing notes in the EHR. In this IRB-approved study, we used EHR data obtained from 162 older adults at TigerPlace, a senior living facility located in Columbia, Missouri. The data included de-identified free-text nursing notes and medications. We pre-processed the data by keeping clinically relevant words. We used pre-trained word embedding models, specifically BioWordVec, and GloVe to train the models. We explored several deep neural architectures and evaluated them to test the effectiveness of each model in predicting future falls. Preliminary experiments show that the LSTM-based deep neural models were most effective in predicting future falls with a sensitivity of 0.72, specificity of 0.67, and a prediction accuracy of 0.75. The model used six months of nursing note data to predict future falls in the next two months. We observed that deep learning models performed better in predicting future falls in a shorter time range as compared to falls in distant future. In addition, the BioWordVec word embedding model was able to capture 17% more clinically relevant words in the text data when compared to GloVe. This exploratory analysis provides groundwork on the use of word embeddings in predicting fall risk from nursing notes.

David Falana

Plainfield, NJ

Su20-031

Sophomore
Electrical Engineering
Rutgers University

Faculty Mentors: Dr. Prasad Calyam, Electrical Engineering & Computer Science; Dr. Khaza Hoque, Electrical Engineering & Computer Science

Funding Source: NSF REU in Consumer Networking Technologies

Attack-Defense and Performance Adaptations for Social Virtual Reality Learning Environments

David Falana, Micheal Fisher, Vaibhav Akashe, Samaikya Valluripally, Khaza Anuarul Hoque, and Prasad Calyam

Social virtual reality learning environment (VRLE) allows one to be virtually present in an immersive manner and increases accessibility to remote learning. VRLE applications in critical domains (e.g. military training, education) demands continuous data delivery along with user immersiveness. Lack of maintaining robustness and high performance in such socio-technical systems, leads to disruption of user safety (e.g inducing cybersickness) and application functionality (e.g. content delivery issue). In this paper, we present a novel adaptive framework that jointly tunes performance and robustness factors using a `DevSecOps' paradigm for a social VRLE. Using a VRLE application case study viz., vSocial we characterize the robustness factors as {Security, Privacy, Safety (SPS)} and performance factors {Quality of Application, Quality of Service, Quality of Experience (3Q)}. For this, we develop an *anomaly-monitoring tool* in our framework to collect and classify anomaly data. Next, we utilize a *decision module* that relies on dynamic decision making for suitable adaptations using quantifiable metrics (e.g. *Suitability, Cost*). To facilitate an adaptive control loop mechanism in our framework, we model a priority queue, to determine the state of VRLE; reduce waiting delays and incorporate adaptations related to severe SPS/3Q anomalies before cybersickness is induced. Based on our experimental results, we enlist best practices to implement for several simulated SPS/3Q anomaly events in vSocial. Our results also detail the benefits of our proposed adaptive control loop framework by performing trade-off analysis of our priority queue model with state-of-the-art approaches, in terms of performance overhead and usability metrics (Response time, Cybersickness). Lastly, we show the effectiveness of our framework for several SPS/3Q scenarios and illustrate the impact of the incorporated adaptations on cost, cybersickness metrics. Based on our results, we demonstrate how our proposed framework takes decisions about the adaptations dynamically to develop a more secure and safer operational social VRLE.

Michael Fisher

Moberly, MO

Su20-044

Senior
Computer Science
Columbia College

Faculty Mentor: Dr. Prasad Calyam, Electrical Engineering & Computer Science

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Attack-Defense and Performance Adaptations forSocial Virtual Reality Learning Environments

Michael Fisher, Samaikya Valluripally, Vaibhav Akashe, David Falana, Khaza Anuarul Hoque, and Prasad Calyam

Social virtual reality learning environment (VRLE) allows one to be virtually present in an immersive manner and increases accessibility to remote learning. VRLE applications in critical domains (e.g. military training, education) demands continuous data delivery along with user immersiveness. Lack of maintaining robustness and high performance in such socio-technical systems, leads to disruption of user safety (e.g inducing cybersickness) and application functionality (e.g. content delivery issue). In this paper, we present a novel adaptive framework that jointly tunes performance and robustness factors using a `DevSecOps' paradigm for a social VRLE. Using a VRLE application case study viz., vSocial we characterize the robustness factors as {Security, Privacy, Safety (SPS)} and performance factors {Quality of Application, Quality of Service, Quality of Experience (3Q)}. For this, we develop an anomaly-monitoring tool in our framework to collect and classify anomaly data. Next, we utilize a decision module that relies on dynamic decision making for suitable adaptations using quantifiable metrics (e.g. Suitability, Cost). To facilitate an adaptive control loop mechanism in our framework, we model a priority queue, to determine the state of VRLE; reduce waiting delays and incorporate adaptations related to severe SPS/3Q anomalies before cybersickness is induced. Based on our experimental results, we enlist best practices to implement for several simulated SPS/3Q anomaly events in vSocial. Our results also detail the benefits of our proposed adaptive control loop framework by performing trade-off analysis of our priority queue model with state-of-the-art approaches, in terms of performance overhead and usability metrics (Response time, Cybersickness). Lastly, we show the effectiveness of our framework for several SPS/3Q scenarios and illustrate the impact of the incorporated adaptations on cost, cybersickness metrics. Based on our results, we demonstrate how our proposed framework takes decisions about the adaptations dynamically to develop a more secure and safer operational social VRLE

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Su20-022

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Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Adipose Tissue-Specific effects of dopamine receptor 1-specific Esr1 deletion in mice

Elyse Frazier, Rebecca Welly, Dusti Shay,and Vicki Vieira-Potter

Estrogen loss may have many effects on women especially during menopause. During menopause women may go through a series of issues including increased weight, hot flashes, disrupted sleep, and increased irritability. Estrogen loss is known to have noticeable effects on weight in women. This is because when estrogen decreases so does the activity rate in female mice. Lower amount of activity will inevitably end in some type of weight gain if diet is the same. Using the mice model, we can make some hypothesis about what is expected to happen in women as well. If mice have lower activity with estrogen loss it is possible that the same happens in women as well. Especially during menopause when estrogen levels tend to drop rapidly. This could create some problems for a women's metabolic health after menopause. When a person has high activity levels it puts them in a position to having an overall healthy life as parts of their body are in their best shape. However, having low estrogen levels can interfere with all these things just by altering activity level. Our goal is to see if the deletion of estrogen receptor 1 (esr1) in dopamine specific brain regions have any effect on adipose tissue. To start this project, we plan on doing cell sizing analysis and UCP1 quantification on brown adipose tissue (BAT) histology samples from the knock out and wild type groups using Image J. As well as look at the gene expression of Ucp1 in BAT using qPcr and wester blot. I cell sized 19 animal ID's BAT. Fir each ID I had 100 cells that were measured for analysis. Each stained image for every ID was measured for Ucp1.

Natalie Gatten

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Su20-004

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Funding Source: NIH grant to Cassandra Boness (F31AA026177)

Cognitive Control as a Mechanism in Alcohol Use Disorder: A Translational Systematic Review of Reviews

Natalie Gatten, McKenna Treece, and Cassandra Boness

A major research goal in the study of addiction is to better understand the underlying causes of substance use disorders, refine their diagnosis, and develop personalized treatments to address them. The Alcohol Addiction Research Domain Criteria (AARDoC) is a mechanism-based framework that aims to identify and characterize the core etiologic processes indicated in alcohol use disorder (AUD). AARDoC describes three functional domains, including cognitive control, reward/incentive salience, and negative emotionality. The overall aim of the current systematic review of reviews was to identify reviews examining AUD etiology, core theories, and associated endophenotypes. Search strategies included comprehensive database searches, manual forward and backward searches, and consultation with experts. The search resulted in a total of 142 eligible reviews, 16 of which fit into the cognitive control domain, which is the focus of the current presentation. Cognitive control describes the executive functions involved in processes such as making decisions, planning, and response inhibition. Within the current framework, cognitive control was broken into impulsivity and compulsivity with conscientiousness and response inhibition falling under the former and compulsive use under the latter. Each of these processes were further divided into increasingly specific mechanistic components and processes, resulting in a hierarchically organized framework. The resulting insight into the specific mechanisms that are encompassed by the cognitive control domain provided by the current review provides a more thorough understanding of the etiologic processes implicated in AUD and provides targets for personalized treatment.

John Gordon

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Su20-032

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Biochemistry

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Funding Source: Cherng Summer Scholars-Honors College

Engineering of High-Oil Plants and Characterization of Their Resistance to Biotic and Abiotic Stress

John Gordon, Aidan Ireton, and Abe Koo

Triacylglycerol (TAG) is a major chemical form of plant storage oil. Besides its use as vegetable cooking oil for human consumption it has numerous other applications as industrial feedstock and as renewable energy source for biofuel production. Hence, there have been constant efforts to increase oil content through various means including genetic engineering. The genes encoding WRINKLED-1 (WRI1) and BIOTIN ATTACHMENT DOMAIN-CONTAINING (BADC) proteins have been identified as genes of interest because they are key regulators in oil biosynthesis as a major transcription factor and a component of initial committed steps to Fatty Acid Synthesis machinery, respectively, and have shown a direct impact on the production of TAG. Genetic crossing of WRI1 Over Expressing (OE) plant lines and BADC RNA Interference (RNAi) lines were used in model plant Arabidopsis thaliana to enhance TAG accumulation. Oil content analysis and quantitative reverse transcriptase polymerase chain reaction experiments are underway to determine the effectiveness of this approach in increasing oil production and altering expression of either genes. WRI1-OE / BADC RNAi plant lines will also be subjected to bioassays designed to measure their resistance to insect pests and high temperatures. This will provide valuable data on any vulnerabilities that high-oil engineering crop plants may create out in the field. In an attempt to preemptively address these foreseeable vulnerabilities, the high-oil plants will be further transformed to express the gene that could enhance the production of jasmonic acid, a major hormone that regulates plant immunity. The final outcome will be to create an ideal bioenergy crop with high oil that can defend better against biotic and abiotic stresses.

Jacob Hager

Harviell, MO

Su20-011

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Economics; Mathematics

Faculty Mentor: Dr. Saku Aura, Economics

Funding Source: Cherng Summer Scholars-Honors College

Analysis of the Effects of Medicaid Expansion and Economic Changes on Social Security Disability Insurance Enrollment Rates

Jacob Hager and Saku Aura

Over the past thirty years, non-elderly Social Security Disability Insurance (SSDI) enrollment rates have increased by over forty percent, though there has been a sudden and steady decrease in the annual number of people enrolling into the program throughout the mid to late 2010's. This decrease in enrollment seems to have begun at the same time as the enactment of the Patient Protection and Affordable Care Act (PPACA) and the state-by-state expansion of Medicaid that was outlined in it. We hypothesize that due to state-by-state Medicaid expansion that was outlined in the PPACA, enrollment rates for SSDI steadily dropped throughout the 2010's due to changes in economic incentives and health insurance availability. Before and after the enactment of the Affordable Care Act, beneficiaries of SSDI were and continue to be eligible for Medicare after a two year wait period starting at the first month that benefits are received. Medicaid expansion allowed for the states that did so to offer their most in-need residents access to health insurance, thereby decreasing a potential enrollee's incentive to apply for SSDI in hopes of receiving Medicare benefits. Using annual state-by-state data from the Social Security Administration, Center for Medicare and Medicaid Services, and the Federal Reserve Economic Data website, we constructed a statistical model in the data analysis software Stata/SE to observe and analyze if any relationship exists between SSDI and Medicare enrollment and PPACA related Medicaid expansion. While there is statistical evidence to partially support our original hypothesis, the downward pre-trend of such enrollment rates prior to the enactment of the PPACA leads us to believe that the PPACA is not the only legal or economic factor influencing SSDI enrollment.

Garret Hall

Su20-007

Elsberry, MO

Sophomore
Plant Sciences

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Funding Source: LIfe Science Undergraduate Research Opportunity Program (LS UROP)

Improving the Production of Oil in an Underutilized Crop: Crambe hispanica

Garret Hall, An Hong, R. Shawn Abrahams, and J. Chris Pires

Crambe hispanica is a relatively new "orphan" crop to the oil industry and may provide certain advantages (resistance, oil content, etc) when compared to other oil crops. My research aims to locate genes involved in the synthesis of Crambe's most notable oil, erucic acid. Erucic acid is economically important, as it is used in the production of biofuels, cosmetics, and surfactants. Locating these genes will help to improve the quality and quantity of erucic acid by providing plant breeders with information to use in crossing and gene editing. Similar research has been done on closely related species, thus proving the viability of this project.

This research is centered around utilizing GWAS (Genome-Wide Association Study), an approach that associates genetic markers with phenotypic traits. Here we use GWAS to locate genes involved in erucic acid synthesis. To accomplish this, the fatty acid composition of seeds will be compared to genotypic data (RNA tissue) from a controlled population of diverse accessions to isolate genes responsible for these specific oil pathways.

Given the recent events with Covid-19, my research on campus was halted and I began working remotely with my lab. Over the summer, I was still able to develop my computational skills in R by working on an existing *Brassica rapa* (turnip) GWAS project. Developing these skills will facilitate the *Crambe* GWAS project when I return to campus in August. I am also planning to extend the *Crambe* experiment to work with Dr. Alex Harkess (one of our collaborators) next summer at Hudson-Alpha, Alabama. By working with Dr. Alex Harkess, I hope to get direct experience in plant genomics and computational biology while also learning about the entrepreneurship environment.

Allison Hamill

St. Louis, MO

Su20-003

Senior
Biomedical Engineering

Faculty Mentor: Dr.Shinghua Ding, Biomedical, Biological & Chemical Engineering

The Role of Astrocytes in Combatting Oxidative Stress After Stroke

Allison Hamill and Shinghua Ding

Astrocytes play an important role in the response to oxidative stress after stroke. While astrocytes respond both positively in an antioxidant capacity as well as negatively in a pro-oxidant capacity, research shows that astrocytes' antioxidant functions are necessary to combat oxidative stress. One such antioxidant function is astrocytic stimulation of the Pentose Phosphate Pathway (PPP), which produces a reducing and antioxidizing agent, NADPH, as its main byproduct. In the PPP, G6PDH plays a role in reduction of oxidative stress by converting NADP to NADPH to promote the production of GSH, a neuroprotective molecule, in astrocytes. Our goal is to genetically engineer a viral DNA plasmid with an astrocyte-specific promoter to express G6PDH selectively in astrocytes to increase the reducing compound NADPH and decrease oxidative stress. We designed DNA primers including a DNA sequence of the G6PDH gene and two restriction enzyme sites. After polymerase chain reactions using the designed primers, we amplified the G6PDH gene which we ligated to the DNA plasmid with an astrocyte-specific promoter gfaABC1D. Finally, the ligated DNA product was transformed into E. Coli., which was cultured for preparation of the recombinant DNA plasmid. The last step was to sequence the DNA plasmid to confirm it was correct. Unfortunately, our first trial did not produce the correct DNA sequence; however, we believe that after a second endeavor, we will successfully generate the correct DNA sequence. We ultimately intend to prepare viral vectors to express G6PDH in astrocytes in mice, and test whether astrocytic G6PDH can reduce oxidative stress after ischemic stroke is induced. Our goal is to determine that overexpression of G6PDH in astrocytes is an effective approach to reducing brain damage through its antioxidant function after stroke.

Emily Harrelson

St. Peters, MO

Su20-016

Junior
Biochemistry

Faculty Mentor: Dr. Charlotte Phillips, Biochemistry

Funding Source: Cherng Summer Scholars-Honors College

Muscle Fiber-typing in the G610C Mouse Model of Osteogenesis Imperfecta

Emily Harrelson, Victoria Gremminger, Cate Omosule, and Charlotte Phillips

Osteogenesis Imperfecta (OI), also known as "brittle bone disease" is an autosomal dominant disease that causes short stature, bone fragility, frequent bone fractures, reduced bone mineral density, and inherent muscle weakness. Currently, the most common treatments for OI are surgical rodding and bisphosphonates. Because bisphosphonates inhibit bone remodeling, there is more bone, but it is poorer quality, therefore it is not a good treatment for children. An alternative way to increase bone strength is to increase muscle mass. When muscles pull on bone with more force, the bone becomes stronger in response. Muscles in patients and mouse models of OI have shown to have force deficits compared to wild type muscles. In a previous experiment, mice modeling severe OI were shown to have significantly less type I oxidative fibers compared to wild type. Mice with the same severe form of OI also display mitochondrial dysfunction in muscle tissues, which together may cause the muscle weakness. One target to make larger muscles is myostatin, a negative regulator of muscle mass. If there is less myostatin, muscles become larger. Using anti-myostatin antibodies, the circulating myostatin levels can be decreased, and muscles can grow larger. Mice with a mild to moderate form of OI, *G610C*, were injected with the anti-myostatin antibodies to determine if bone and muscle quality or size was improved. This project focuses muscle fiber-type composition changes between wild type and *G610C* mice and between mice of both genetic backgrounds given a control treatment versus the anti-myostatin antibodies. The results of this study will be shown at the Summer Undergraduate Research Forum.

Mollie Harrison

Su20-001

Kirkwood, MO

Senior
Chemical Engineering

Faculty Mentor: Dr. Bret Ulery, Biomedical, Biological & Chemical Engineering

Funding Source: Cherng Summer Scholars-Honors College and MTF Biologics

Hydrogen peroxide releasing biomaterials for vascularization in bone tissue regeneration

Mollie J. Harrison, Brittany N. Allen, and Bret D. Ulery

In the United States, 5-10% of bone fractures result in nonunion. Traditional solutions such as autografts and allografts have significant side effects, including donor site morbidity and disease transmission, respectively. Although new regenerative engineering treatments have been developed, their high cost and limited scalability have prevented their widespread clinical adoption. An additional limitation of bone tissue regeneration is inherent tissue complexity as vascular and neural networks must be regenerated in addition to osteoblasts. The Biomodulatory Materials Engineering Laboratory is working to develop a cheaper and more widely applicable option for large volume bone repair using novel biomaterials. This project focuses specifically on using the simple signaling molecule hydrogen peroxide to induce the differentiation of endothelial cells from mesenchymal stem cells for bone tissue vascularization applications.

First, the therapeutic window for the differentiation of mesenchymal stem cells into endothelial cells using hydrogen peroxide was determined by exposing the cells to various concentrations of hydrogen peroxide for one, three, and seven days. Proliferation and differentiation of the cells was determined for each timepoint using DNA/ATP assays and fluorescent microscopy, respectively. A novel hydrogen-peroxide-releasing biomaterial was then synthesized by modifying glutamic acid with hydrogen peroxide to form a peroxy acid (i.e., perglutamic acid).

Future research will focus on leveraging perglutamic acid as a monomer for various degradable polymers (e.e, polyanhydrides, polyesters, polyamides), for which cell studies can be conducted guided by the already established therapeutic window. The effects of these new biomaterials on off-target cells will also be studied. After biomaterials for osteogenesis, angiogenesis, and neurogenesis have each been synthesized, they can be integrated for large volume bone repair through tissue regeneration.

Angel Herrera

Su20-038

Tacoma, WA

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Computer Science; Business Administration (Management)
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Funding Source: NSF REU in Consumer Networking Technologies

Multi-Drone Coordination for Aerial Imaging

Angel Herrera, Alec James, Miles Krusniak, Yi Shang, and Prasad Calyam

Drone technology has proven to be helpful in the automation of various monotonous tasks, ranging from search and rescue to crop monitoring. In our case, we wish to expand the capabilities of a dynamic-height single-drone algorithm for area coverage path planning to multiple drones. We propose two algorithms to plan both paths and height management for a team of quadrotor drones trying to spot and count birds in various distributions within an area enclosed by an arbitrary polygon. We propose a solution to a case in which bird locations are known to follow a certain set of density distributions. We split the area into two sub-regions of high and low density to be traversed differently from one another. Our cooperative approaches aim to reduce the time it takes to cover all aforementioned birds while at the same time increasing counting accuracy when compared to a single-drone approach, and a naive multi-drone approach that does not adapt to density. Our measurement of utility will be through accuracy, and time and energy spent.

Robert Ignatowicz

Staten Island, NY

Su20-028

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Faculty Mentor: Dr. Prasad Calyam, Electrical Engineering & Computer Science; Dr. Kannappan Palaniappann, Electrical Engineering & Computer Science

Funding Source: NSF REU in Consumer Networking Technologies

Enhancing Network-edge Connectivity and Data Security in Drone Video Analytics

Robert Ignatowicz, Alexander Riddle, Alicia Esquivel Morel, Deniz Kavzak Ufuktepe, Chengyi Qu, Kannappan Palaniappan, and Prasad Calyam

Unmanned Aerial Vehicle (UAV) systems with high-resolution video cameras are used for many operations such as aerial imaging, search and rescue, and precision agriculture. Multi-drone systems operating in Flying Ad Hoc Networks (FANETS) are inherently insecure and require efficient and end-to-end security schemes to defend against cyber-attacks. Providing a framework that can defend against three common attack vectors in UAV systems, Man-in-the-middle (MITM), Replay and Denial of Service (DoS) attacks, in this project, we propose a cloud-based, intelligent security framework viz., "DroneCOCoNet-Sec" that provides network-edge connectivity and data security for drone video analytics. Our framework ensures communication and data transmission between UAV systems and edge-server, including three main modules: (ii) a secure hybrid testbed management module that synergies simulation and emulation via an open-source network simulator and a research platform for mobile wireless networks, (ii) an intelligent and dynamic Machine Learning decision algorithm to detect anomaly events in the system without decreasing the performance in a real-time FANET deployment, and (iii) a web-based experiment control module that features a graphical user interface to assist users in the execution/visualization of repeatable and high-scale experiments. Our performance evaluation experiments result demonstrated the effectiveness of our framework, defending against MITM, Replay and DoS attacks, and ensuring the Network-edge Connectivity and Data Security in Drone Video Analytics.

Clayton Ivie

Su20-051

O'Fallon, MO

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Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity; (NIH) F32 HL120570, American Heart Association Grant 15SDG 25080095, NIH R00 HL130339

Changes in respiratory-sympathetic coupling during hyperinsulinemia in healthy young adults

Clayton L. Ivie[1], Dain P. Jacob[1], Michael T. Mozer1, Blair D. Johnson[2,3], Timothy B. Curry[3], Jacqueline K. Limberg[1,3]

Background: Breathing patterns can modulate the autonomic nervous system (i.e., respiratory-sympathetic coupling). A number of studies have demonstrated elevated muscle sympathetic nerve activity (MSNA) during hyperinsulinemic-euglycemic clamp conditions. Elevated systemic insulin also increases ventilation in healthy young adults; however, interactions between the two systems (i.e., respiratory-sympathetic coupling) during hyperinsulinemia have not been explored. The present investigation sought to examine the effect of hyperinsulinemia on respiratory-sympathetic coupling in humans.

Hypothesis: We hypothesized during high systemic insulin we would observe an increase sympathetic nervous system activity during late expiratory phase of the respiratory cycle (i.e., increased respiratory-sympathetic coupling) when compared to measures during baseline.

Methods: Twenty healthy young adults (13M/7F; 28$\pm$1 yrs) completed a single study visit. Heart rate (ECG), MSNA (microneurography of the peroneal nerve) and respiration (pneumotachometry) were measured continuously at baseline and during a 60-min hyperinsulinemic (1 mU/kg FFM/min), euglycemic infusion. Cardiac and respiratory modulation of MSNA was quantified at baseline and following insulin infusion by fitting polynomials to the cross-correlation histograms constructed between the sympathetic spikes and either ECG or respiration.

Expected Results: Insulin increased during the infusion ($p<0.01$) and glucose was maintained ($p>0.05$). Plasma epinephrine (47$\pm$5 to 61$\pm$6 mg/mL), norepinephrine (164$\pm$15 to 208$\pm$16), and MSNA (30$\pm$2 to 37$\pm$3 bursts/100 heart beats) were increased during the infusion ($p<0.05$). Although analysis is ongoing, we expect to observe an increase in respiratory modulation during hyperinsulinemia compared to baseline. We propose changes in the respiratory patterning of MSNA in the context of hyperinsulinemia will include more activity during late expiration and less activity during post-inspiration.

Alec James

Columbia, MO

Su20-036

Sophomore
Computer Science
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Funding Source: NSF REU in Consumer Networking Technologies

Multi-Drone Coordination for Aerial Imaging

Alec James, Angel Herrera, Miles Krursniak, and Yi Shang

Drone technology has proven to be helpful in the automation of various monotonous tasks, ranging from search and rescue to crop monitoring. In our case, we wish to expand the capabilities of a dynamic-height single-drone algorithm for area coverage path planning to multiple drones. We propose two algorithms to plan both paths and height management for a team of quadrotor drones trying to spot and count birds in various distributions within an area enclosed by an arbitrary polygon. We propose a solution to a case in which bird locations are known to follow a certain set of density distributions. We split the area into two sub-regions of high and low density to be traversed differently from one another. Our cooperative approaches aim to reduce the time it takes to cover all aforementioned birds while at the same time increasing counting accuracy when compared to a single-drone approach, and a naive multi-drone approach that does not adapt to density. Our measurement of utility will be through accuracy, and time and energy spent.

Lydia Jefferson

Raytown, MO

Su20-018

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Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Estimating Stream Metabolism By Use of RStudio®

Lydia Jefferson and Alba Argerich

Primary production and aerobic respiration are the major processes that dictate how organic matter is processed in streams and metabolic energy flow. Through the use of the Integrated Development Environment (IDE) RStudio®, daily observations of water temperature, stream depth, and dissolved oxygen concentrations can be used to estimate the daily gross primary production (GPP) and aerobic ecosystem respiration (ER). The above mentioned data will be collected from a freshwater body located in Swope Park, Kansas City, Missouri and compared to the data from a freshwater body in the Tri-State Mining District in Joplin, Missouri. Further, these observations will be compared to the data from a variety of sites throughout the United States available from the U.S. Geological Survey's (USGS) National Water Information System (NWIS) to determine the relative influence that land use has on stream metabolism. By observing these freshwater bodies over a long-term period of time, the influence of stream flow, precipitation, and other seasonal variations on stream metabolism rates will also be determined. By quantifying the metabolic energy flow in streams and rivers across the United States, this study seeks to improve the understanding of how stream metabolism rates relate to the overall health of the stream.

Cayla Johnson

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Su20-023

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Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Evaluation of levels of circulating mitochondrial DNA in maternal blood as markers of Intrauterine Growth Disorders

Cayla Johnson, Kylie Hohensee, Mackenzie Giunio-Zorkin, Mistie Mills, and Rene Cortese

According to the CDC, obesity is defined as having a BMI of 30kg/ m^2 or more. This condition leads to complications during pregnancy, like babies being born small or large for their gestational age (SGA and LGA pregnancies, respectively). Intrauterine growth restriction (IUGR) also known as fetal growth restriction is the inability of a fetus to reach its capacity for growth. According to the American College of Obstetricians and Gynecologists, it is "the most common and complex problem in modern obstetrics." Fetal Growth Disorders (FGD) are linked with several other events like congenital anomalies, cerebral palsy, neonatal death, metabolic disorders and more. FGDs are currently detected by ultrasonographic monitoring and clinical evaluation. The precision of such approaches is limited by fetal size, usually requiring mid to late gestational age for detecting FGD. Hence, the development of high precision methods enabling early detection is needed. Circulating fetal DNA holds a high potential value for monitoring fetal health. Cell-free fetal DNA is abundantly released into the bloodstream of the mother, thus providing a noninvasive opportunity for collection of fetal DNA through the mother's plasma. This study was designed to evaluate a method for FGD detection based on the ratio of DNA between mitochondrial and nuclear circulating in the plasma fraction of maternal blood. By targeting specific DNA sequences through qPCR, it is possible to quantify the DNA that is released mitochondria and the nucleus from the total amount of isolated nuclei acids. Blood samples will be collected from pregnant women at different gestational age and the plasma fraction will be separated by centrifugation. The DNA present in the plasma will be isolated using the Circulating Nucleic Acids kit (Qiagen). The mitochondrial-nuclear DNA ratio (MNR) in maternal plasma will be quantified using qPCR. In this approach mitochondrial and nuclear DNA are quantified using assays specific for mitochondrial and nuclear DNA sequences, respectively. We hypothesize that the MNR will be significantly different in patients with FGD compared with normal growing pregnancies. Circulating mitochondrial levels will be compared with normal, LGA and SGA pregnancies at each trimester and will be evaluated using statistical methods (i.e. ANOVA, Kruskal-Wallis test). The variable information collected for the study (e.g. age, BMI, etc.) will be assessed by multivariate analysis. This study will be the first to evaluate the utility of MNR as a marker for monitoring fetal growth. We anticipate that MNR that indicate FGDs in pregnancies will enable an individual approach to manage these pregnancies. These disorders will be predicted and identified earlier than by standard methods, and plans can be created for each patient to treat them according to their individual disorders.

Andrew Jones

Cincinnati, KY

Su20-025

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Biological Sciences

Faculty Mentor: Dr. Elizabeth King, Biological Sciences

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Effect of diet variability on reproductive traits of Drosophila melanogaster

Andrew Jones, Enoch Ng'oma, and Elizabeth King

All organisms take in food and use the resources they gain from it to allocate towards any number of different body functions. Processes such as somatic maintenance, reproduction, and longevity all vie for the same pool of nutrients. One of the most important functions to any organism is reproduction. In *Drosophila melanogaster,* studies have observed the effect of adult fly diet on life history traits such as fecundity. Little research, however, has been undertaken to understand how developmental diets influence adult reproductive phenotypes. The aim of this project was to determine the independent effects of the larval and adult diets on the fecundity of flies. To carry out this project, we used a population of outbred flies and gave them one of two larval diets: control (C) and dietary restriction (DR) to simulate a high and low nutritional diet. Once flies reached adulthood, they were released to cages and diets either carried over into adulthood or were alternated to observe any effects. Fecundity was measured every other day with a standard egg-laying period of three hours. Our results show that flies raised on restricted diet as larvae laid more eggs total and had more eggs per-female than those given richer diet. In addition, fecundity patterns also demonstrate "boom and bust" cycles of high fecundity per-female in cages followed by lower fecundity per-female. This cycle repeated itself several times in the months of data collection. This pattern could indicate that flies are possibly alternating allocation of resources between body functions or maintenance. Further analysis will seek to discern the origins of this phenomenon. Future plans for this project include examination of similar dietary effects on other life history traits such as fly size.

Benjamin Jones

Hebron, KY

Su20-010

Senior
Biological Sciences

Faculty Mentor: Dr. Erika Boerman, Medical Pharmacology & Physiology

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Role of Endothelin Converting Enzyme-1 and Neprilysin in Perivascular Sensory Nerve Dysfunction with IBD

Benjamin W Jones, Elizabeth Grunz-Borgmann and Erika Boerman

Inflammatory Bowel Diseases (IBD) are chronic diseases that are diagnosed in around 70,000 Americans each year, and 1.6 million Americans in total. IBD is closely associated with cardiovascular complications, including arterial stiffening and ischemic heart disease. Blood flow to the intestines is impaired with IBD, and dilation of the mesenteric arteries is facilitated by perivascular sensory nerves, through the release of calcitonin gene related peptide (CGRP) and substance P (SP). Previous experiments suggest that CGRP and SP receptors function abnormally and fail to facilitate artery dilation during IBD. To study those pathways further, we looked at two components of the CGRP and SP signaling pathways. The metalloproteases endothelin-converting enzyme-1 (ECE) and neutral endopeptidase (NEP) are very important to the GCRP and SP pathways because they control the degradation and the recycling of CGRP and SP receptors. My preliminary experiments yielded two major results: (1) decreased ECE and NEP content in mesenteric arteries with IBD and (2) colocalization of surface and internalized CGRP and SP receptors with both ECE and NEP in isolated smooth muscle cells from mesenteric arteries. Therefore, we hypothesize that IBD decreases receptor and metalloprotease colocalization and internalization after sensory nerve stimulation, leading to decreased receptor recycling and impaired sensory vasodilation. We also predict that IBD decreases the effect of NEP and ECE inhibition on sensory vasodilation in intact, cannulated arteries. To test these hypotheses, C57BL/6, IL10-/- mice will be inoculated with Helicobacter hepaticus by gastric gavage after weaning and develop IBD over 90 days. Non-gavaged C57BL/6 mice will serve as controls. Confocal imaging (Leica TCS SP8) of cannulated, immunolabeled mesenteric arteries will determine how IBD affects CGRP/SP receptor recycling and NEP/ECE expression and localization after exposure to one or both neuropeptides. In separate experiments, pressure myography will be used to examine how IBD affects the role of ECE and NEP in vasodilation of live vessels. Sensory vasodilation will be measured before and after pharmacological blockade of one or both metalloproteases. Myography data will be analyzed via GraphPad Prism. Previous studies suggest that CGRP and SP signaling and receptor trafficking is altered specifically in blood vessels (mesenteric arteries and aorta) and their directly adjacent tissues (perivascular adipose and serum). If results indicate that IBD alters the role of NEP and ECE expression and activity in sensory neurotransmitter signaling and vasodilation, targeting ECE and/or NEP activity in IBD patients may have the potential to eventually improve both blood flow and intestinal function.

Dominique Joseph

Su20-041

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Biological Sciences; German

Faculty Mentor: Dr. Charlotte Phillips, Biochemistry

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Histological Response to Myostatin and Activin Antibodies in the *Osteogenesis Imperfecta* Murine Model

Dominique Joseph, Catherine Omosule, Sandra Kleiner, Charlotte L. Phillips

Osteogenesis imperfecta (OI), also known as brittle bone disease, is an incurable connective tissue disorder primarily caused by mutations in the type I collagen genes and phenotypically manifested in type I collagen-containing tissues, particularly bone. Our laboratory uses the G610C murine model to study OI, where wild type (WT) G610C mice do not exhibit increased susceptibility to fractures, skeletal deformities, and muscle weakness as seen in the heterozygous G610C mouse (+/G610C).

Bone is mechanosensitive and responds to high mechanical loads by stimulating new bone formation and altering bone geometry to withstand increased forces. Myostatin (mstn), a member of the TGF-β superfamily, is a negative regulator of muscle growth. Previous pharmacological inhibition of myostatin in +/G610C mice using the soluble activin receptor type IIB-mFc (sActRIIB-mFc) fusion protein resulted in increased hindlimb skeletal muscle weight with improved contractile function. The underlying molecular mechanism of sActRIIB-mFc remains unknown, and negative side effects in humans have been noted, likely due to the receptor's ability to bind multiple targets in addition to myostatin.

Among sActRIIB-mFc targets, myostatin and activin-A (act-A) are known to regulate bone and muscle growth. Thus, we treated male WT mice with isotype control-antibody, anti-myostatin (anti-M), or anti-activin-A (anti-A) specific antibodies for 11 weeks, starting at 5 weeks of age to investigate the impact of decreased circulating mstn and actA in bone growth and stability.

Bone is composed of three major cell types: osteoblasts, osteocytes, and osteoclasts. Osteoblasts are cells which secrete the matrix for bone formation. I have been performing histological examination of osteoclast numbers and sizes to determine the effects of myostatin antibodies (mstn-ab) and activin antibodies (act-ab) on cell numbers.

We hypothesize that postnatal inhibition of myostatin or activin-A would reduce osteoclast number and activity in G610C mice, though more data is needed to determine full effects on bone.

Hamza Khan

St. Louis, MO

Su20-014

Senior
Environmental Sciences (Land and Soil)

Faculty Mentor: Robin Rotman, School of Natural Resources

Potential Earthquake Damage Extent in States Bordering The New Madrid Fault Zone

Hamza Khan and Robin Rotman

The issue this project addresses is the New Madrid Fault zone and the possibilities of damage within the surrounding area of the zone. In 1812, there was a series of earthquakes that shocked the Midwest, caused the Mississippi River to flow backwards, and rang bells in Boston. These series of earthquakes damaged up to and over 600,000 square kilometers, uplifting huge amounts of that land, as well as causing landslides and massive waves on the Mississippi. The three main earthquakes produced huge amounts of damage spanning to St. Louis. While remaining dormant for now, faults can give at any moment and cause earthquakes like the ones from the past. Within this Geographic Information Systems (GIS) project, analysis of data from the earthquakes in 1812, as well as current population and structural data of towns was used to create maps that show the susceptibility of liquefaction within the surrounding states of the fault zone. There is no clear solution, as these events are random, it is a significant piece of information to know when building new homes, buildings, schools, etc.

Leo Koenigsfeld

Su20-019

Frankenstein, MO

Senior
Biochemistry; Plant Sciences

Faculty Mentor: Dr. Paula McSteen, Biological Sciences

Funding Source: Cherng Summer Scholars-Honors College

Examining Interactions between the tassel-less4 (tls4) Mutant and Auxin in Maize

Leo Koenigsfeld, Janlo Robil, Mika Nevo, Dennis Zhu and Paula McSteen

Plant growth and development is an important field of research which has the potential to greatly increase agricultural productivity. An increased understanding of how organs develop as well as the factors that control plant growth would allow for the development of new technologies in improving plant growth for various purposes. One important factor that controls plant development is the plant growth hormone, Auxin. Auxin is an integral part of numerous aspects of plant growth, including lateral growth and organ formation (McSteen et al 2007). However, despite Auxin's essential role in plant growth and development our understanding of how it functions is incomplete. To gain further insight into how Auxin functions in plants, mutants that have problems involving Auxin are used. This project examines the *tassel-less4* (*tls4*) mutant in maize to determine how it interacts with Auxin. *tls4* is a mutant in maize that has a phenotype characteristic of Auxin mutants. To determine how the gene responsible for *tsl4* interacts with Auxin, double mutants were generated between *tls4* and mutants that have known defects in Auxin. Double mutant analyses are currently being performed with *sparse*-inflouresence1(Gallavotti et al 2008) and *vanishing-tassel2* (Phillips et al 2011), both of which are known to function in Auxin biosynthesis. The results of these analyses should be obtained by late August. The interactions between these mutants should provide a more complete picture of how Auxin functions in plants as well as how *tls4* interacts with Auxin.

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Madison LaChance

Su20-020

Chesterfield, MO

Junior
Biological Sciences

Faculty Mentor: Dr. Kevin Middleton, Pathology and Anatomical Sciences

Funding Source: Cherng Summer Scholars-Honors College

How Does Selection for Increased Exercise in Mice Impact Mandible and Tooth Shape and Size?

Madison LaChance, Faye McGechie, Anna Hardin, Scott Kelly, Theodore Garland, Jr., Kristina Aldridge, and Kevin Middleton

Teeth are often the most well-preserved body part in fossils and erupt at full size while being sustained across the course of the animal's life. This allows for a variety of information to be gained upon analysis of teeth that can be useful in understanding both function and evolution. Head and tooth structure have been used to infer diet in human ancestors, however other factors might influence these traits, such as activity, food consumption, and genetics. To understand the roles of these additional factors, we investigated the relationship of activity level on mandible and teeth shape and size in a sample of male mice (n = 57) that has undergone selection for high running, a control, and a high running population with a muscle mutation resulting in smaller muscles. We predicted that there would be significant differences in shape between groups due to the differences in energy usage and distance ran.

Data was collected by placing 37 surface landmarks on surface models generated from micro-CT images. These landmarks were placed over the entirety of the skull with an emphasis on the mandible and tooth row in order to study the overall shape. To analyze the landmark data, we used linear regression of centroid size on line and wheel access and MANOVA on aligned coordinates by line and wheel access.

We found that there was no significant difference in centroid size between lines of mice or with wheel access. There were highly significant differences between the lines for overall shape, but no difference in shape depending on wheel access. This indicates that there is an effect of activity level over generations of selection on the shape of the mandible. These results support our prediction that shape would be significantly different between groups of varying activity levels.

Juliann Leak

Su20-024

Kansas City, MO

Junior
Biological Sciences; Psychology

Faculty Mentor: Dr. Laura Schulz, Obstetrics, Gynecology and Women's Health

Funding Source: Cherng Summer Scholars-Honors College; NICHD R01HD094937

Investigating the role of ACTC1 in placental development

Juliann Leak, Rowan Karvas, Jessica Milano-Foster, Toshihiko Ezashi, Danny Schust, R. Michael Roberts, and Laura C. Schulz

The placenta is important for proper nutrient and oxygen exchange from mother to fetus. As the human placenta develops, single cytotrophoblast cells fuse into a large multinucleated cell (syncytiotrophoblast) covering the surface contacting maternal blood. Little is known about early placental development and which genes are responsible for guiding proper cell fusion. Previous work in our lab has investigated a gene called ACTC1, which encodes a cardiac actin required in formation of cardiac muscle. Defects in this gene are associated with idiopathic dilated cardiomyopathy, familial hypertrophic cardiomyopathy, and atrial septal defect. ACTC1 has been studied in cardiac development, but not in the placenta. Our hypothesis is that ACTC1 plays a role in cell fusion and is required for proper placental development. Previously, we have shown that ACTC1 is expressed during syncytium formation in the human placenta, and in trophoblast cells derived from human embryonic stem cells, a partial removal of this gene showed morphological changes and reduced cell fusion. The purpose of the current experiment is to determine whether ACTC1 is present in the mouse placenta at various points in gestation, specifically when syncytium is first forming (E8.5-10.5) and in the mature placenta (E11.5-E18.5). Immunofluorescence staining with an ACTC1 antibody showed specific signal in paraffin sections of a positive control tissue (mouse heart) and no expression in a negative control tissue (mouse pancreas). Preliminary results show that ACTC1 is expressed at gestational days 8.5 and 10.5 in parietal trophoblast giant cells but is not expressed in the mouse placenta at days 11.5 and 18.5. Contrary to expectations, ACTC1 was not expressed in developing chorion cells, which is not consistent with the hypothesis that ACTC1 plays a role in syncytiotrophoblast cell fusion in the mouse placenta. A future direction for this project would investigate placental development in an ACTC1 knockout mouse.

Brandon Lee

Kearney, MO

Su20-002

Senior
Chemical Engineering; Physics

Faculty Mentor: Dr. Karl Hammond, Biomedical, Biological & Chemical Engineering

Funding Source: Scientific Discovery Through Advanced Computing – SciDAC (K.D. Hammond)

Temperature Effects on the Relief Pressure of Helium Bubbles in Tungsten

Brandon F. Lee and Karl D. Hammond

Obtaining energy from nuclear fusion presents a significant materials engineering challenge. Tungsten, the current material of choice for the plasma-facing divertor of magnetic-confinement fusion reactors, is known to develop a network of microscopic tendrils, dubbed "fuzz," when exposed to helium plasma. The mechanism behind fuzz formation is not well-understood, but the formation of helium bubbles below the surface is known to play a role. This study utilizes molecular dynamics to analyze the effects of temperature and surface proximity on the pressure at which helium bubble expansion and/or bursting occurs. As expected, raising the temperature lowers the pressure at which bubbles of a given size and depth will expand or burst, but the magnitude of the change decreases as the temperature increases. The relief pressure also falls off near the surface: the relief pressure at all tested temperatures is generally well-described by an empirical equation of the form $P_r = P_b (1 - e^{-Cd})$, where P_r is the relief pressure, P_b is the relief pressure in the bulk (far from the surface) at the same temperature, d is the depth of the bubble, and C is an adjustable parameter. The empirical correlation will be used in future simulations of helium bubbles in tungsten divertors at spatial and temporal scales comparable to the dimensions and operating windows of real devices, which are impossible to reach with atomic simulations.

John Lewis

Olathe, KS

Su20-042

Junior
Computer Science; Mathematics
Florida Southern College

Faculty Mentor: Dr. Kannappan Palaniappann, Electrical Engineering & Computer Science; Dr. Prasad Calyam, Electrical Engineering & Computer Science

Funding Source: NSF REU in Consumer Networking Technologies

Truth, Trust, and Transparency in Synthetic Media

John K. Lewis, Imad Eddine Toubal, Helen Chen, Vishal Sandesera, Michael Lomnitz, Zigfried Hampel-Arias, Calyam Prasad, and Kannappan Palaniappan

Authenticity of digital media has become an ever-pressing necessity for modern society. Since the introduction of Generative Adversarial Networks (GANs), synthetic media has become increasingly difficult to identify. Synthetic videos that contain altered faces and/or voices of a person are known as deepfakes and threaten trust and privacy in digital media. Deepfakes can be weaponized for political advantage, slander, and to undermine the reputation of public figures. Despite imperfections of deepfakes, people struggle to distinguish between authentic and manipulated images and videos. Consequently, it is important to have automated systems that accurately and efficiently classify the validity of digital content. Many recent deepfake detection methods use single frames of video and focus on the spatial information in the image to infer the authenticity of the video. Some promising approaches exploit the temporal inconsistencies of manipulated videos; however, research primarily focuses on spatial features. We propose a hybrid deep learning approach that uses spatial, spectral, and temporal content that is naturally coupled in a consistent way to differentiate real and fake videos. In this work, we build a computationally efficient cloud-ready multimodal system to detect deepfake videos. We evaluate the performance of our proposed system compared to recent approaches, in terms of accuracy and speed, on the Facebook Deepfake Detection Challenge and FaceForensics++ video datasets.

Amara Mason

Su20-029

Alsip, IL

Sophomore
Biological Sciences

Faculty Mentor: Dr. Pamela Brown, Biological Sciences

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Succinoglycan Production in Agrobacterium tumefaciens

Amara Mason, Jacob Bouchier, and Pam Brown

Secretion of an acidic polysaccharide known as succinoglycan is required for plant host invasion by the bacterial phytopathogen, *Agrobacterium tumefaciens*, leading to the formation of crown galls. How is succinoglycan used during plant invasion? One possibility is that succinoglycan is involved in conferring pH tolerance in the acidic environment surrounding the roots of a plant. Recently, our group has accumulated data supporting another possibility: that succinoglycan protects bacteria from growth inhibition and cell wall damage. Upon the depletion of the essential cell wall synthase PBP1a, *A. tumefaciens* loses its ability to elongate and begins upregulating production and secretion of succinoglycan. To explore the link between cell wall synthesis and succinoglycan production, I dissected various components of the succinoglycan regulatory and biosynthesis pathways and observed changes in shape with microscopy. I found that there is indeed a link between succinoglycan biosynthesis and cell wall synthesis. Additionally, I localized the succinoglycan secretion machinery and found that it colocalizes with the growth pole, further implicating a connection between PBP1a and the regulation of succinoglycan production. In an effort to further investigate pathways regulating succinoglycan production upon loss of PBP1a activity, I developed a forward genetic approach to screen a library of transposon mutants for misregulation of succinoglycan production upon depletion of PBP1a. The screen relies on a high throughput method of detecting a dye called calcofluor white that binds succinoglycan and fluoresces under a UV light. I optimized the screen for use in a plate reader and ran 48 mutant colonies as a trial. I expect that after screening more mutants, I will identify additional proteins involved in the regulation of succinoglycan and shed more light on the link between cell wall synthesis and succinoglycan production in *A. tumefaciens*.

Senay Mengesteab

Columbia, MO

Su20-035

Sophomore
Biological Sciences

Faculty Mentor: Dr. Jill Kanaley, Nutrition and Exercise Physiology

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Sleep restriction and altered sleep timing on energy intake and energy expenditure

Senay Mengesteab, Rebecca Shafer, and Jill Kanaley

Studies have shown that in healthy young adults, undesirable physiological changes are a result of chronic sleep curtailment. Some of these physiological changes harm inflammatory status, blood glucose regulation, and insulin sensitivity. A majority of studies that examined the topic of sleep restriction have not considered whether restricted sleep is due a subject going to bed later in the night or waking up earlier in the morning. This study will examine the changes in physical activity and food intake during multiple periods of sleep restriction to determine the effects of shortened sleep on potential changes in physical activity and energy intake.

Subjects will wear an activity monitor (actigraph) and a sleep monitor (actiwatch) for six days and will have to record and take a picture of everything they eat in a dietary to record energy intake The first condition of the three, consists of the subject wearing the actigraph and the actiwatch and monitoring their food intake for six days of normal sleep. In the second and third condition, subjects will maintain their usual physical activity and dietary patterns, but we will ask subjects to either delay the time they go to bed by two hours or wake up two hours earlier than they normally would. Subjects will go through four nights of shortened sleep but collect data for six days. We hypothesize that after several nights of short sleep that different strategies are employed to remain awake, and these strategies will also vary whether bedtime was delayed, or wake time was advanced. If this hypothesis turns out to be true, it will help influence the field of nutrition and exercise physiology to look more into the effects behind the two different forms of restricted sleep.

Gilberto Perez

Su20-015

Independence, MO

Senior
Biochemistry

Faculty Mentor: Dr. Yves Chabu, Biological Sciences

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Multi-analyte liquid biomarkers for lung cancer detection and risk assessment

Gilberto Perez and Yves C. Chabu

Lung cancer is the leading cause of cancer deaths. Early detection and surgical resection generate a 5 year survival of 56% compared to only 5% for patients with more advanced (stage III/IV) disease. However, early lung cancer is largely asymptomatic and 80% of patients present with stage advanced disease at diagnosis. Current screening approaches heavily rely on low-dose computed tomography (LDCT), which is often inaccurate, especially in early disease patients, and lead to costly, unnecessary, and invasive follow-up procedures. There is a need for robust early detection strategies. In addition, EGFR mutations activate compensatory resistance mechanisms, leading to highly lethal anti-EGFR resistant lung cancers. The molecular bases of these mechanisms are largely unknown. Understanding and targeting these mechanisms will provide a basis for stratifying and sensitizing patients to therapies.

Liquid biopsies have the potential to noninvasively detect cancers while capturing the broader cancer signaling landscape, which in principle provides a rational for matching patients to appropriate therapies. We isolated plasma extracellular vesicles (EV) from high-risk control and stage IV lung cancer patients and asked whether stage IV EV have unique morphometric characteristics. Importantly, we isolated and sequenced microRNAs (miRNAs) from plasma and EV from the same cohorts and have identified sets of miRNAs that reliably distinguishes stage IV patients from controls. In addition, mutational and copy number alteration analyses of microRNA gene targets using lung cancer genome and outcome data have identified prognostic biomarkers for EGFR mutated lung cancers. We are now evaluating whether targeting these miRNAs or common gene targets re-sensitizes EGFR cancers to EGFR blockade. Thus, our newly identified liquid biomarkers have the potential to improve lung cancer diagnosis and to assist in the effective stratification of patients to anti-EGFR therapies.

Alisha Perry

South Bend, IN

Su20-043

Senior
Biological Sciences

Faculty Mentor: Dr. Elizabeth Parks, Nutrition and Exercise Physiology

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

Hepatic short chain fatty acid (SCFA) oxidation in nonalcoholic fatty liver disease

Alisha Perry, Justine Mucinski, Majid Mufaqam Syed-Abdul, Jennifer Snawder, Ayman Gaballah, Randy Scott Rector, Jamal A. Ibdah, and Elizabeth J. Parks

Reduced fat oxidation in liver mitochondria is hypothesized to be a primary cause of excess liver fat and tissue injury in nonalcoholic fatty liver disease (NAFLD). A definitive test of this hypothesis currently requires a liver biopsy to obtain tissue for mitochondrial isolation and in-vitro testing. The goal of the study was to develop a noninvasive method to investigate liver fat oxidation in humans. To accomplish this, we chose to utilize the SCFA octanoate because it is uniquely cleared by the liver and enters the mitochondria without need for a carrier protein. For the breath test, stably-labeled, ^{13}C-octanoate (23.4 mg) was fed in orange juice and breath samples collected 8 times over a 135-minute period. Total CO_2 production rate was measured by respiratory gas analysis (Parvo Medics) and $^{13}CO_2$ enrichment assessed by isotope-ratio mass-spectrometry (IR-MS). 12 NAFLD patients (4 men, 8 women, 44$\pm$3 years) underwent diagnostic liver biopsy and liver tissues were scored histologically by a pathologist to determine the level of liver disease (NAFLD activity score: 0, (healthy) to 8, (cirrhosis)). In addition, six patients participated in a 9-month, lifestyle treatment program followed by a repeat liver biopsy. Data from the $^{13}CO_2$-breath test was compared to the NAFLD score. Preliminary results from two of the lifestyle-treated subjects available so far demonstrated greater fat oxidation after treatment. Ongoing work will complete the analysis of data from the other subjects. Octanoate oxidation data will be compared to liver histology, the NAFLD score, liver fat measured by MRI, body composition assessed by DEXA, blood concentration of metabolites, and whole-body fat oxidation calculated using the respiratory quotient. Using a direct comparison to data from isolated liver tissue in humans, this method will be the first evaluation of the efficacy of an in-vivo breath test that quantitates liver fat oxidation in patients with NAFLD.

Tessi Rickabaugh

Fulton, MO

Su20-037

Junior
Religious Studies,
Interdisciplinary (Women's and Gender Studies)

Faculty Mentor: Dr. Kate Kelley. Religious Studies

Funding Source: MU Honors College, Peggy and Andrew Cherng, and the Panda Charitable Foundation.

Examining the impact of Christian purity culture on adults' sexuality, identity, and religious practices

Tessi Muskrat Rickabaugh and Kate S. Kelley

Evangelical Christian purity culture, most popular between 1990 and 2010, is an approach to abstinence-only sex education within Evangelical culture. Youth are taught to follow purity culture mandates such as: protecting virginity and practicing modesty, purity of thought, and avoidance of intimacy before commitment to marriage. This study examines the outcomes of growing up in this culture, with a focus on the impact on later relationships and religious practice. An initial short form survey, distributed through social media, yielded 564 responses with 250 interview volunteers in one week. Due to interview limitations, the short form survey was replaced with a long form survey that included the two validated measures: The Mosher Sex Guilt Scale and Ashdown's Sex Satisfaction Scale, as well as dichotomous questions and open-ended questions. 714 short survey responses and 357 long survey responses were received. Ten interviews were performed, focusing on participants' experience in Purity Culture and their former and current religious practices. Analysis is ongoing, but preliminary survey findings include: 54% of respondents indicate their experience with purity culture was "extremely negative", while only 18% of respondents identified it as "extremely" or "somewhat" positive. Of respondents, 41% still identify as Christian, with 18% now identifying as agnostic, 13% as nothing in particular, and 12% as atheist. Sixty-seven percent of respondents took a formal vow of purity and 62% of those became sexually active before marriage. Additionally, 77% of respondents reported experiencing shame, sexual aversion, or some other negative emotion attributed to purity culture, and 38% have sought professional help with these issues. Future direction includes studying the impacts of purity culture on LGBTQ persons, siblings, and heterosexual couples both raised in purity culture. An additional area of inquiry is the experiences of participants who sought therapy for issues they attribute to their experiences in purity culture.

Alexander Riddle

Columbia, MO

Su20-033

Sophomore
Computer Science

Faculty Mentor: Dr. Prasad Calyam, Electrical Engineering & Computer Science; Dr. Kannappan Palaniappann, Electrical Engineering & Computer Science

Funding Source: NSF REU in Consumer Networking Technologies

Enhancing Network-edge Connectivity and Data Security in Drone Video Analytics

Alexander Riddle, Robert Ignatowicz, Alicia Esquivel Morel, Deniz Kavzak Ufuktepe, Chengyi Qu, Kannappan Palaniappan, and Prasad Calyam

Unmanned Aerial Vehicle (UAV) systems with high-resolution video cameras are used for many operations such as aerial imaging, search and rescue, and precision agriculture. Multi-drone systems operating in Flying Ad Hoc Networks (FANETS) are inherently insecure and require efficient and end-to-end security schemes to defend against cyber-attacks. Providing a framework that can defend against three common attack vectors in UAV systems, Man-in-the-middle (MITM), Replay and Denial of Service (DoS) attacks, in this project, we propose a cloud-based, intelligent security framework viz., "DroneCOCoNet-Sec" that provides network-edge connectivity and data security for drone video analytics. Our framework ensures communication and data transmission between UAV systems and edge-server, including three main modules: (ii) a secure hybrid testbed management module that synergies simulation and emulation via an open-source network simulator and a research platform for mobile wireless networks, (ii) an intelligent and dynamic Machine Learning decision algorithm to detect anomaly events in the system without decreasing the performance in a real-time FANET deployment, and (iii) a web-based experiment control module that features a graphical user interface to assist users in the execution/visualization of repeatable and high-scale experiments. Our performance evaluation experiments result demonstrated the effectiveness of our framework, defending against MITM, Replay and DoS attacks, and ensuring the Network-edge Connectivity and Data Security in Drone Video Analytics.

Margot Ruff

Omaha, NE

Su20-049

Freshman
Biological Sciences,
Romance Languages (Spanish)

Faculty Mentor: Dr. Shawn Bender, Biomedical Sciences

Vascular Recovery During Ischemia

Margot Ruff, Scott Brown, and Shawn Bender

Abstract withheld due to proprietary permissions.

Donia Shawn

Su20-013

Columbia, MO

Junior
Biological Sciences; Psychology

Faculty Mentors: Dr. Iris Zachary, Health Management and Informatics; Dr. Uzma Khan, Medicine; Dr. Magda Esebua, Pathology and Anatomical Sciences

Funding Source: Cherng Summer Scholars-Honors College

Association of Body Mass Index and Thyroid Stimulating Hormone Levels with Thyroid Cancer Among Genders in MU-TNED (MU-Thyroid Nodule Electronic)

Donia Shawn, Iris Zachary, Uzma Khan, and Magda Esebua

Introduction: Thyroid cancer is increasing in the US, making it the sixth most common cancer especially in women according to SEER data. The National Cancer Institute has identified thirteen cancers associated with obesity, including thyroid cancer. Higher BMI has been associated with a slight (10%) increase in the risk of thyroid cancer. Thyroid stimulating hormone (TSH) is a hormone produced by the pituitary gland to regulate thyroid function. This study focuses on investigating the association between TSH, BMI, and the risk of thyroid cancer among males and females in the MU-Thyroid Nodule Electronic Database (MU-TNED), that includes patients with nodular thyroid disease.

Methods: A retrospective chart review of MU-TNED and the electronic medical record system used by the University of Missouri Healthcare, called Powerchart, was used to evaluate the extracted patient history of patients from 2014-2019. Patients were divided into groups of higher BMI ($\geq$30) and lower BMI (<30), patients with malignant disease (thyroid cancer) and patients with no malignancy. Descriptive statistics were used to assess the data. A logistic regression was used adjusting for BMI and TSH assessing the association of thyroid cancer with BMI, TSH, and gender.

Results: A total of 3,000 patients were evaluated from MU-TNED. BMI and TSH showed a p-value that was statistically significant ($p<0.05$). Results of our data show that BMI and TSH are related to a slightly higher risk of thyroid cancer. There is also a higher risk of developing Thyroid cancer when TSH levels are $\geq$4 and BMI is $\geq$30 in patients with nodular disease.

Conclusion: We confirmed that BMI and TSH are statistically significant in regard to developing Thyroid cancer. High BMI and TSH levels are associated with a higher risk of developing Thyroid cancer. Among genders, male and female, females have a higher risk of developing Thyroid cancer.

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Paige Smith

St. Peters, MO

Su20-017

Senior
Public Health

Faculty Mentor: Dr. Enid Schatz, Public Health

Funding Source: Cherng Summer Scholars-Honors College

Well-being implications of COVID-19: A mixed-methods study of the University of Missouri students

Paige Smith and Enid Schatz

College students have been uniquely impacted by the COVID-19 pandemic. Non-pharmaceutical preventative measures have uprooted college students' lives through campus closures and stay-at-home orders. This mixed-methods longitudinal study was created to observe the pandemic's effects on college students through the 2020 summer semester by surveying changes in various aspects of well-being. 230 University of Missouri students enrolled in the study. The in-depth baseline survey compared their situation in February 2020 (pre-COVID-19 pandemic) to their situation in June 2020 (during COVID-19 pandemic). The project continued through the distribution of six shorter weekly surveys and a final in-depth survey to track the effects of the pandemic over time. Results from the baseline survey have been collected thus far, which has led to a few key findings. The rate of student employment has decreased, and a majority of students moved home with their families and spent significantly less time with their friends. Students have also been delaying their needed health care due to the pandemic. Mental health has been largely impacted as well, with the majority of students experiencing at least mild depression (59.47%) and anxiety symptoms (48.68%). These results will be shared with university faculty and administration to assist in creating tailored accommodations for students in future semesters.

Jack Suárez

Su20-030

Bryant, AR

Senior
Biological Sciences; Psychology

Faculty Mentor: Dr. Jeffrey Johnson, Psychological Sciences

Funding Source: MARC/IMSD - NIH-funded Maximizing Access to Research Careers/ Initiative for Maximizing Student Diversity

A meta-analysis of behavioral and electrophysiological evidence for episodic retrieval mode

Jack Hamilton Suarez, Brittney Bishop, and Jeffrey Johnson

Episodic and semantic memory disruptions coincide with, and sometimes preclude, a variety of psychological disorders. These disruptions can take multiple forms, not only reflecting the loss of mnemonic information, but also relating to deficits in strategic processing, executive function, and decision making. This project is focused on characterizing the strategies employed by healthy young adults to retrieve episodic versus semantic memories, with the longer-term goals of using the electrophysiological correlates of such processes to understand age-related memory decline and to develop avenues for cognitive rehabilitation. The primary aim of the proposed project is to further elucidate the cognitive and neural basis of a process known as *retrieval mode*, which supports retrieval by allowing the rememberer to engage in a cognitive state that is conducive to using stimuli as cues for episodic memories. Here, we provide a meta-analysis of behavioral and electrophysiological studies of episodic retrieval, with particular focus on event-related potential (ERP) measures that have shown inconsistent support for the adoption of retrieval mode. Our main hypothesis is that the disparate results are due to differences in difficulty between the episodic retrieval tasks employed, and the various semantic tasks that are commonly used as control conditions. While evidence in favor of retrieval mode has often been demonstrated when comparing with simple semantic judgments (e.g., animacy or size), null results might arise when the semantic task is more engaging than the episodic task (e.g., is this object found more often indoors vs. outdoors?). The findings of this project will be instrumental in facilitating the development of experimental designs to further test the limiting conditions of retrieval mode using ERPs and other neuroimaging methods, such as functional magnetic resonance imaging (fMRI).

Landon Swartz

Columbia, MO

Su20-008

Junior
Computer Engineering

Faculty Mentor: Dr. David Mendoza, Plant Sciences

Funding Source: Cherng Summer Scholars-Honors College and NSF grant to David Mendoza (MCB-1818312)

Accelerated Gene Discovery Through Automated Hydroponics

Landon Swartz, Chris Zachary, and David Mendoza

Agriculture is one of the most important sectors of the economy for every nation in the world. But crop production is not projected to meet the growing needs of a world population approaching 10 billion by the year 2050. Furthermore, the use of fertilizers and intensive agriculture practices is unsustainable for the world ecosystem in the long term. More sustainable and resilient crop traits and variants are needed to combat this. Hydroponics, or growing plants in nutrient solution, has been an important way to study and express phenotypes for gene discovery of such crop traits and variants. However, the process is error prone and very labor intensive. Solution changes and phenotyping are manually. This summer, through the generosity of the Cherng Summer Scholars Program and the Honors College, I designed an automated hydroponics system to be used in conjecture with high-throughput phenotyping to quickly identify important phenotypes and related genotypes within the model organism *Arabidopsis Thaliana*. An automated hydroponics system was developed from a combination of 3D modelling, embedded systems design, and plant biology. It collects PH, dissolved oxygen, and conductivity from the solution over time of an experiment through use of high-precision sensors. It also captures images at a time interval using a high-resolution camera that can be image processed to quantify phenotypes using computer vision. A test experiment for the sensors was conducted. A phenotype was failed to be seen so the experiments will be conducted again. This system will be a great addition to the Mendoza lab's research and other research within the Life Science Center.

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Cognitive Control as a Mechanism in Alcohol Use Disorder: A Translational Systematic Review of Reviews

McKenna Treece, Natalie Gatten and Cassandra Boness

A major research goal in the study of addiction is to better understand the underlying causes of substance use disorders, refine their diagnosis, and develop personalized treatments to address them. The Alcohol Addiction Research Domain Criteria (AARDoC) is a mechanism-based framework that aims to identify and characterize the core etiologic processes indicated in alcohol use disorder (AUD). AARDoC describes three functional domains, including cognitive control, reward/incentive salience, and negative emotionality. The overall aim of the current systematic review of reviews was to identify reviews examining AUD etiology, core theories, and associated endophenotypes. Search strategies included comprehensive database searches, manual forward and backward searches, and consultation with experts. The search resulted in a total of 142 eligible reviews, 16 of which fit into the cognitive control domain, which is the focus of the current presentation. Cognitive control describes the executive functions involved in processes such as making decisions, planning, and response inhibition. Within the current framework, cognitive control was broken into impulsivity and compulsivity with conscientiousness and response inhibition falling under the former and compulsive use under the latter. Each of these processes were further divided into increasingly specific mechanistic components and processes, resulting in a hierarchically organized framework. The resulting insight into the specific mechanisms that are encompassed by the cognitive control domain provided by the current review provides a more thorough understanding of the etiologic processes implicated in AUD and provides targets for personalized treatment.

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"Dear Heart of Glass Kids" An artistically experimental non-fiction short film process

Evann Twitchell and Stacey Woelfel

Generations and moments in history can be defined and remembered by the works of art that emerged from them. Young artists hold a critical perspective in this mosaic of expression and documentation, yet their less experienced voices are largely unheard. The short film, Dear Heart of Glass Kids, follows three artists in their early 20's at the threshold of their careers, as they collaborate remotely to build an artistic time capsule that speaks to their possible future children as well as the child in all of us.

My cast is made up of Justin Bobbs, a hip-hop musician/producer, Margie Crosby, an illustrator, and Stephanie Roston, a contemporary-modern choreographer. Though separated by thousands of miles, they have been sharing newly created works and searching for commonalities emerging throughout them in virtual collaboration sessions all summer. Though we are unable to culminate the project with in-person work, due to COVID-19, we are constructing an ending scene for the film that integrates all three artforms by layering creative processes through post-production techniques. A few individual scenes have been shot in-person, but the rest I have directed remotely with hands-on help from family members within the artists' quarantines. I aim to finish filming by September and I hope to complete the editing process by late fall 2020.

Adapting to COVID-19 and emotionally engaging with the heartache many people in our country are facing right now has made this project both challenging and unmistakably personal. It has encouraged the artists to create and share more work than they would on their own and has been validating to their agency as creators in a world which often overlooks unseasoned professionals. Though this season is extremely tumultuous for filmmakers and artists, Dear Heart of Glass Kids is continually teaching me about the value of artistry, perspective, faith, and vulnerability in such a moment as this.

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Vibrational Communication in Juvenile Enchenopa Binota Treehoppers Recruits Nymphs to Initiate Group Foraging

Brandy Williams, Sabrina Michael, and Reginald Cocroft

There are very few studies on how vibrational communication facilitates group foraging. Understanding the function of this communication in the *Enchenopa* treehopper would be very instrumental to further understanding their mechanisms of group living. There are many studies done on adult insect communication, but not many concerning juveniles. This project will address both of these understudied areas. Treehoppers feed on plant sap, and since plants have many defense mechanisms, it is important for treehoppers to find a good food source and take full advantage of it before the plant releases defensive chemicals. Juvenile treehoppers practice group living, and therefore communicate with each other often by using their bodies to generate vibrations that are sent through the host plant. There are multiple types of messages to be sent to group members, leaving room for development of different calls. *Calloconophora pinguis* is a treehopper species that uses vibrations to signal to other treehoppers where a good food source is, using a call and response method. The response could be the treehopper replicating the call and walking to the signaler, or just exclusively walking to the signaler; this suggests that the calls act as a form of recruitment. This study will focus on *Enchenopa binotata* on Viburnum plants. *Enchenopa* nymphs have previously been found to produce several different vibrations in various contexts, but the function of these signals has not been tested. I suspect that *Enchenopa* nymphs are also using this type of "call and response" communication system to locate and advertise feeding sites. This project will utilize the same procedure used in the study done by Reginald Cocroft in his 2005 paper studying vibrational communication in phloem-feeding insects. In this experiment, one nymph will be used for each playback for a total of 10 trials. There will be a playback of the potential recruitment signal, along with silence and wind vibrations as controls, each coming from one playback device. The location of the three playback treatments (signal, wind, silence) will be varied between trials. The responsiveness of the treehopper will be measured by their distance from the recruitment signal at the end of the playback, as they will be starting off at the base of a cut stem. Based on other studies done on *Tylopelta* treehoppers, as well as preliminary observations of the *E. binotata* nymphs, I expect the *Enchenopa* treehoppers to walk towards the source of the recruitment playback. This would show that the signals attract nymphs from the group to participate in group foraging. This experiment would allow us to look deeper into the role group size plays in decision making in juvenile treehoppers. Juvenile treehoppers are rarely alone, but since there are usually multiple groups on a plant, it would be helpful to understand how the treehoppers decide which group to follow.